

The University of Chicago

AN EXPERIMENTAL TEST OF THE
THEORY OF ASSOCIATIVE
INTERFERENCE

A PART OF A DISSERTATION SUBMITTED TO
THE FACULTY OF THE DIVISION OF THE
BIOLOGICAL SCIENCES IN CANDIDACY FOR
THE DEGREE OF DOCTOR OF PHILOSOPHY

DEPARTMENT OF PSYCHOLOGY

1934

By

JOSEPH WILLIAM NAGGE

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INTRODUCTION

The experimental work on retroactive inhibition has led to the formulation of two main explanatory hypotheses. The first of these is the Perseveration Theory formulated by Müller and Pilzecker (17). The second is that of Associative Interference.

The Perseveration Theory rested upon the assumption that, after learning, the neural elements involved therein continued to be automatically excited for a period of time. This perseveration process was held to be essential to a proper fixation and any interference with it led to forgetting. Hence the temporal position of the interpolated activity, in relation to the first activity, should be an important factor in the production of retroactive inhibition. The greatest retroactive inhibition should occur when the interpolated material is learned immediately after the original material. Robinson (21), Whitely (26), and McGeoch (10) (11) in two studies, have failed to verify the assumption. Skaggs (23) offers data which bear out the assumption.

The Associative Interference Theory holds that when interpolated learning occurs, associations are set up between elements of the interpolated and original materials which tend to disrupt the original learning by cross association. The reinstatement of the first activity, after the acquisition of the second, requires the dissociation of elements from the new context and the ultimate recombining of them into their original system of relationships. The Theory of Associative Interference leads to the following deductions: (1) the amount of retroaction should increase as the degree of similarity of the original and the interpolated activities increases; (2)

the amount of retroaction should decrease with the greater degree of integration of the original material; and (3) retroactive inhibition should decrease as the conditions of association between the first and the interpolated activities are lessened through dissociation. The first of these deductions is made upon the assumption that the closer the similarity of the first and the second activities, the greater will be the number of associations common to both and hence the greater the interference. The second deduction follows the assumption that the greater the integration of the material the more firmly will its associative bonds be made, and hence the more resistant it will become to associative interference from the second. The third deduction is based upon the assumption that as the conditions of association between the two activities are lessened, there will be less opportunity for cross associations, and hence, less interference. The first deduction is supported by the work on similarity by Robinson (21), Whitely (26), Skaggs (23), Harden (6), Cheng (3), McGeoch and McDonald (13), and Johnson (8). The second deduction is supported by the work of McGeoch (12), Robinson and Heron (22), and by that of Tolman (24). The third deduction has not been adequately tested. Mitchell's (16) experiment is the only test of the assumption. Her experiment, however, is inadequate as she presents data from but two subjects and hence makes no statistical treatment. The method of dissociation employed was that of hypnosis. The original and the interpolated learning occurred in the hypnotic or in the waking states. Altogether there were four conditions of the experiment, two dissociated and two control conditions. Those conditions in which the original and the interpolated learning occurred in different states showed no advantage in retention over the control conditions in which both activities proceeded in similar states. Rather the dissociated state conditions showed a lower retention than the control conditions. Further and more adequate tests should be made of this third assumption. It is the purpose of the following experiments to further test this assumption.

EXPERIMENTS

Problem

It is the purpose of the experiments which follow to further test the third assumption of the Theory of Associative Interference, that retroactive inhibition should decrease as the conditions of association between the first and the interpolated activities are lessened through dissociation. The Theory of Associative Interference holds that, in the fixation of the interpolated activity, some of the associative connections established in the original activity are somehow cut across and new associations formed. It is these cross associations which interfere with the retention of the first activity. It follows from the theory that the interpolated activity should interfere in less degree with the retention of the original activity, where the conditions of association between the two activities are lessened. Will less retroactive inhibition occur where the conditions of association of the original activity with the interpolated activity are lessened? Is it possible to dissociate an interpolated activity from the original so that no retroactive inhibition will appear, in the relearning of the first, as a result of the learning of the second? Positive answers to these questions would be interpreted as evidence in favor of the Theory of Associative Interference.

The following experiments deal with four aspects of the general problem. If the first activity is mediated by vision and the second learning activity by audition, how will the retroactive effects compare with those resulting when both activities are mediated by vision? If the first activity takes place in one room environment and the second in a different room environment, how will the resulting retention compare with that of the control condition? If the original learning involves dextral manual activity and the second learning involves sinistral manual activity, how will retention compare with that in which both activities involve a common manual activity? If the original material is learned in the waking state and the interpolated material is learned in the hypnotic state, will retention be higher than if both materials are learned in the waking state?

Experiment I: Dissociation through Change in the Method of Presentation of Material

Problem.—If the interpolated material to be learned is presented visually and the original material is presented auditorially, to what degree will the interpolated material interfere with the retention of the original material?

Method.

The learning materials consisted throughout of lists of twelve nonsense syllables. These were printed in $\frac{3}{16}$ " type on flexible cardboard. In the visible learning the material was presented by means of the Chicago memory drum. The syllables of a list were exposed at intervals of three seconds until learning was complete. The same procedure was followed during relearning. A four-second interval was interpolated between the successive presentations of the list.

The auditory material was presented under the same conditions, except that the syllables were spelled aloud (e.g., F-I-H) by the experimenter. Care was taken that enunciation was clear. The order of the syllables of the lists was so arranged that rhyming of neighboring letters was eliminated, insofar as possible, in order that cues extraneous to the material should not influence the speed of learning.

The anticipation method of learning was used. The lists were presented until the subject could make one perfect written anticipation of the material. Interpolated learning began immediately after the completion of the learning of the first material. Recall and relearning followed twenty-four hours after the completion of the original learning.

The lists of syllables were circulated, throughout all of the conditions of the experiment, so as to equalize the effects of possible differences in difficulty, between any list or lists, upon any one condition or conditions. The different subjects learned the series of conditions in counterbalanced orders, in order to distribute the practice effects throughout the various conditions.

Twenty-four subjects, twenty men and four women, comprised the experimental group. All of the subjects, excepting two, were graduate students in psychology at the University of Chicago. The two untrained subjects were put through a preliminary training period in the learning of nonsense syllables before proceeding to the experimental work. All subjects worked in every condition of the experiment.

The conditions of the experiment were as follows:

	Method of Presentation of Material (Original)	Method of Presentation of Material (Interpolated)	Method of Presentation of Material at Recall
Condition A.....	Auditory	Auditory	Auditory
Condition B.....	Auditory	Visual	Auditory
Condition C.....	Visual	Auditory	Visual
Condition D.....	Auditory	Rest	Auditory
Condition E.....	Visual	Visual	Visual
Condition F.....	Visual	Rest	Visual

At the time of recall the following typical instructions were given: "Yesterday you learned two lists of nonsense syllables. The first list was learned visually and

the second list learned auditorially. I now want you to anticipate as many of the syllables of the first list as you can, on the first presentation of that material. The list will be presented to you in the same fashion as it was yesterday. Relearn this list as rapidly as possible."

Results.—Table I shows the effects of sensory dissociation of the interpolated material upon the retention of the first material learned. Data are presented in terms of the average savings and anticipation scores, the difference between these scores on the comparable conditions, and the reliability of these differences in terms of their probable errors.

TABLE I

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Condition A.....	.5370±.0275		.2099±.0300	
Condition B.....	.6397±.0152		.2732±.0245	
Diff.....	.1027±.0271*	3.79	.0633±.0292	2.16
Condition E.....	.4941±.0311		.2033±.0198	
Condition C.....	.6113±.0181		.2999±.0264	
Diff.....	.1172±.0335	3.49	.0966±.0305	3.16

* Since all of the subjects worked in all of the conditions of the experiment the probable error of the difference of the means formula involves the correlation of the data of the two conditions compared.

An examination of Table I reveals a greater savings score in Condition B, where the interpolated learning is sensorially dissociated from the original learning activity, than in Condition A, where there is no such sensory dissociation, but where the learning activities are mediated by a common sense avenue. The first lists were auditorially presented in both Condition A and in Condition B. The difference between the means of the savings scores is almost four times the probable error of the difference. This represents a satisfactory reliability. The difference between the average anticipation scores of the same two conditions is in the same direction as that between the savings score averages, but is not as reliable a difference.

In the same table, a comparison of the average savings scores of Conditions C and E, reveals that the dissociated

condition again shows reliably the higher score. The average anticipation score of Condition C is also greater than that of the control condition. The original learning in each of these cases was visual.

Table II shows the average savings and anticipation scores of the Conditions B and C, in each of which the second learning activities were sensorially dissociated from the first, in relation to those of Conditions D and F, respectively. In these latter conditions single lists only were learned.

TABLE II

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Condition D.....	.6807±.0226		.5032±.0383	
Condition B.....	.6397±.0152		.2732±.0245	
Diff.....	.0410±.0199	2.06	.2300±.0419	5.48
Condition F.....	.6472±.0190		.4057±.0317	
Condition C.....	.6113±.0181		.2999±.0264	
Diff.....	.0359±.0250	1.43	.1058±.0401	2.63

It will be noted in Table II that the average savings score of Condition B, where the first activity was mediated by audition, and the second by vision, approaches that of Condition D, in which a single list was auditorially learned. The same situation holds in the comparison of Conditions F and C. The differences in anticipation scores appear to be more reliable than those in savings scores in both comparisons.

In Table III comparisons are made of the average savings

TABLE III

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Conditions A+E.....	.5155±.0210		.2066±.0179	
Conditions B+C.....	.6255±.0119		.2865±.0175	
Diff.....	.1100±.0242	4.54	.0799±.0251	3.18
Conditions F+D.....	.6640±.0162		.4545±.0262	
Conditions B+C.....	.6255±.0119		.2865±.0175	
Diff.....	.0385±.0201	1.91	.1680±.0315	5.33

and anticipation scores of the control Conditions B and C combined, with those of the dissociated Conditions A and E combined, and with those of the single list Conditions F and D combined.

When the experimental Conditions B and C are combined and compared with the combined control Conditions A and E, the differences in average savings and anticipation scores become even more reliable. A combination of the average savings and anticipation scores of the single lists F and D, when compared with a corresponding combination of the experimental Conditions B and C, shows a reliable difference in average anticipation scores, but not in average savings scores.

Reed (20) has shown that if the material to be learned is presented auditorially or visually, retention is higher when the relearning proceeds by the same method of presentation as that employed during learning.

The results of Experiment I reveal that less retroactive inhibition results when the first and the second activities separately involve the auditory or the visual sensory tracts than when the two activities involve the same sensory pathways. This result may be interpreted in terms of the Theory of Associative Interference, which assumes that retroactive inhibition increases as the number of common neural elements involved in the two activities increases.

Summary.—1. When two activities are learned, and the first of these is mediated by vision and the second by audition, or vice versa, there is less retroactive inhibition than when both activities involve the same visual or auditory pathways.

2. When two learning activities are sensorially dissociated the amount of retroaction of the second material on the retention of the first, as measured by the savings score, is not reliably higher than that which occurs when no interpolated activity is introduced. However, if the differences in anticipation scores are considered, there are reliable differences in favor of the single list conditions.

Experiment II: Dissociation through Change of Environment

Problem.—Retroactive inhibition may possibly be traced to the association of the first and the interpolated materials to be learned with the extra-organic setting in which they occur. Thus the same stimulating conditions may bring about an interference between the two activities by cross association. If the original and the second learning activities occur in one environment, which is common to both, then, since both would tend to be associated with the same environment, there should be a number of associations formed between the two activities and large interference should result.

The problem of this experiment is to determine whether a lesser retroactive inhibition follows when the first activity is learned in one environment and the interpolated activity is learned in a second environment, than that which follows the control condition, in which both activities, original and interpolated, occur in the same environment.

Method.

The method of learning was essentially the same as that outlined under Experiment I except that all learning materials were presented visually. Where a second list was to be learned, one minute elapsed between the completion of the learning of the first and the beginning of the learning of the second. This interval was allowed in order that the subject could pass to the second room for the interpolated learning, in the condition where this was necessary.

Twenty-four subjects, all students in psychology at the University of Chicago, comprised the experimental group. The three undergraduate students in the group were unpracticed in the learning of nonsense syllables and were trained, therefore, in this function for three periods preliminary to the beginning of the experimental work. Nineteen men and five women served as subjects. All subjects worked in each condition of the experiment.

The conditions of the experiment were as follows:

	Learning Environment		Relearning Environment
	List I	List II	List I
Condition A.	Room I	Room I	Room I
Condition B.	Room I	Room II	Room I
Condition C.	Room I	Rest	Room I

It was attempted to make the room environments in which the learnings occurred strikingly different from each other. The rooms differed in size and in the nature of

the arrangements of their contents. In each the experimenter oriented himself in space with respect to the subject in a different manner. The memory drums used were different models of the Chicago drum. Room I was lighted by a Mazda lamp which brought all of the environment into clear relief. In Room II the illumination consisted of a beam of red light which issued from an aperture cut in a tin hood, which otherwise completely enclosed the source of illumination. The beam of light was directed upon the face of the drum on which the learning material was exposed. Sufficient light was deflected so that the subject could write his anticipation of the material without being handicapped in the task by insufficient illumination. The room environment, beyond the memory drum, was thus poorly lighted. Pressey (19) has suggested a relationship between the speed of learning and the degree of illumination. Three students judged the illumination of the materials to be learned in the two environments to be equal.

Before the relearning began the subjects were given the following typical instructions: "Yesterday you learned two lists of nonsense syllables. The first list was learned in this room and the second list in the other room. I now want you to anticipate as many syllables of the first list as you can on the first presentation of that material. Relearn this list as rapidly as possible."

Results.—Table IV shows the average savings and anticipation scores of the various conditions of the experiment, the differences between these, and their probable errors.

TABLE IV

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Condition B.....	.4680±.0316		.1770±.0238	
Condition A.....	.4526±.0319		.1874±.0236	
Diff.....	.0154±.0419	0.37	.0104±.0294	0.35
Condition C.....	.6790±.0209		.4096±.0305	

An examination of the average scores presented shows no noteworthy differences between the respective averages of the experimental Condition B and its control Condition A.

There have been many experimental findings which indicate that a change at the time of recall in the sensory environment in which a habit is fixated has a detrimental effect on that recall. One possible explanation of this detrimental effect would be the absence of the proper stimulating conditions.

Yum (29) has demonstrated that stimuli, similar to those which were originally associated with an activity, may call

forth that activity. Stimuli which approach each other in similarity tend to call forth the same response.

In Experiment II we wished to determine whether there was a greater or a lesser retroactive inhibition when opportunity was given for both the interpolated and the original activities to be associated with the same environment rather than with different environments. From the past work on forgetting it would seem probable that a first and a second activity, each associated with different stimulating conditions, would lead to as great a degree of retroactive inhibition and interference as when these two activities were associated with a common environment. The results as presented in Table IV show no reliable differences resulting from a dissociation of the environments.

Summary.—1. When the original learning activity occurs in one environment and the interpolated activity occurs in a second environment, the resulting savings and anticipation scores are no greater than when both learning activities occur in a common environment.

2. Since no more retroactive inhibition is present in the condition where both activities occur in different environments than is to be found in the condition where the environment is common to the two activities, it appears that the presence of a common room environment does not mediate a closer association between the original and the interpolated activities.

Experiment III: Dissociation through Change in Manual Activity during Learning

Problem.—The problem that is the concern of Experiment III is the following one. If the original activity involves the left hand and the interpolated activity involves the right hand, to what degree will the interpolated activity interfere with the retention of the first activity?

Webb (25) studied transfer of training and retroactive inhibition in rats and human subjects. The experimental data were gathered from maze learning activities. Among the problems he attacked were: (a) the dependence of transfer

upon the nature of the first and the second learning activities; and (b) the possible retroactive inhibition effected by one or more activities upon the other. He reports that (1) there were practically no cases of habit interference when total errors, time, and trials were the criteria considered; and (2) the degree of similarity of the mazes and the nature of the first and the second activities were the factors found to influence the degree of transfer. Wiltbank (27) found, while training rats in maze habits, that a positive transfer in both time and errors occurred from one maze to another. Brockbank (1) trained rats on a circular maze until mastery. A thirty-day training period then followed on a rope-ladder problem. Retention of the first habit was then tested. The interpolated activity did not appear to decrease the average retention. When the interpolated activity consisted of training on a saw-dust problem box, the same general lack of interference with the retention of the first habit was established.

Method.

The method by which learning proceeded was essentially the same as that of Experiment II. The exposure time was four seconds per syllable since this period was found to be the optimum for left-handed writing. Interpolated learning followed immediately after the completion of the original learning. The subject wrote the material as it was learned, with either the right or the left hand, according to the condition of the experiment.

The experimental group was composed of twenty-four subjects, four women and twenty men. All of the subjects were graduate students in the University of Chicago. All subjects worked in every condition of the experiment.

The conditions of the experiment were as follows:

	Hand of Motor Activity		
	List I	List II	Recall List I
Condition A.....	Right	Left	Right
Condition B.....	Left	Right	Left
Condition C.....	Left	Rest	Left
Condition D.....	Left	Left	Left
Condition E.....	Right	Rest	Right
Condition F.....	Right	Right	Right

At the time of relearning the subjects were instructed typically as follows: "Yesterday you learned two lists of nonsense syllables. You wrote the first list with the

left hand as you learned it. The second list was written with the right hand. Relearn the first list as soon as possible, writing with your left hand."

Results.—Table V shows the average savings and anticipation scores of those conditions of the experiment in which the first and the second activities involved different hands, compared with the corresponding scores of those conditions in which the activities involved the same hands. Differences are shown between the average scores and their probable errors are indicated.

An examination of Table V shows that when both the first and the second activities involve different hands there

TABLE V

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Condition A.....	.5336±.0237		.2246±.0187	
Condition F.....	.5048±.0328		.1992±.0212	
Diff.....	.0288±.0330	0.87	.0254±.0253	1.00
Condition B.....	.5829±.0323		.2934±.0308	
Condition D.....	.5099±.0303		.2065±.0286	
Diff.....	.0730±.0409	1.78	.0869±.0270	3.22

is a tendency toward greater savings and anticipation scores than when both habits involve the same hand. The reliability of the differences is not high but the differences are consistent in the direction of their trends.

Table VI shows the difference in average savings and

TABLE VI

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Condition E.....	.6472±.0190		.4057±.0317	
Condition A.....	.5336±.0237		.2246±.0187	
Diff.....	.1136±.0317	3.58	.1811±.0360	5.03
Condition C.....	.7059±.0163		.4637±.0263	
Condition B.....	.5829±.0323		.2934±.0308	
Diff.....	.1230±.0379	3.24	.1703±.0358	4.81

anticipation scores between Conditions A and E. In the first condition the original activity involved the right hand and the interpolated activity the left hand. Condition E involved a single right hand activity. Likewise, the average retention scores of the dissociated Condition B and the single activity Condition C are compared. In these latter two conditions the first activity involved the left hand.

The table shows highly reliable differences between the dissociated conditions and the single list conditions. This finding is to be contrasted with that of the experiment on sensory dissociation, where no reliable difference was found between the average savings scores of the dissociated lists and those of the single list conditions.

Table VII shows the differences between the combined savings and anticipation score averages of the dissociated Conditions A and B and those of the combined control Conditions D and F.

TABLE VII

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Conditions A+B.....	.5582±.0202		.2590±.0177	
Conditions D+F.....	.5073±.0225		.2028±.0182	
Diff.....	.0509±.0258	1.97	.0562±.0234	2.40

The results indicate that when the first of two activities involves a motor process different from that of the second there is a tendency toward less retroactive inhibition than when the original and the interpolated activities involve the same motor process. While the differences are in no case significantly reliable the general unbroken trend of the data is a factor to be considered.

Summary.—When the interpolated activity involves a different manual motor process from that of the first activity there is a consistent tendency towards a higher savings and anticipation score than when both activities involve the same motor pathways.

Experiment IV: Dissociation through Hypnosis

Problem.—The literature of abnormal psychology frequently makes reference to certain phenomena, such as double personality, automatic writing, hypnosis, etc. Many experiences present in these states seem to have no connection with those of the waking state, since they appear to be unrecallable when the subject is in a normal state. A noteworthy phenomenon of the hypnotic state is a frequently appearing amnesia for its events when the subject is awakened. There appears to be a dissociation of the experiences of the two states.

Such a dissociation, it is expected, would produce a lower degree of associative interference when the original and the interpolated materials are learned in the hypnotic and the waking states, respectively, than that produced when both are learned in the hypnotic state. Such a finding could be interpreted as further evidence in favor of the Theory of Associative Interference.

It is the purpose of Experiment IV to determine whether or not less retroactive inhibition follows the learning of a second material in a state dissociated from the first. The problem may be stated more explicitly as follows: If the interpolated material is learned while the subject is in the hypnotic state and the original material is learned in the waking state, to what degree will the interpolated material interfere with the retention of the original material?

Method.

The learning tasks consisted in the learning of nonsense material to the point of one perfect repetition. The lists were eleven syllables in length. These were presented by means of the Hull memory apparatus at the rate of one syllable each two seconds. Four seconds elapsed between the successive presentations of a list. The subjects anticipated the material by spelling it aloud.

When an interpolated material was involved in a condition, learning commenced ten minutes after the completion of the first learning. This period of time was allowed for the induction of the hypnotic state. Thus, this period of time elapsed in all of the conditions of the experiment before the interpolated learning began. Relearning followed fifty-five minutes after the completion of the original learning and proceeded by the same anticipation method. During the rest periods the subjects were engaged in the reading of light narrative material. After the completion of the interpolated learning, the subjects always spent the interval of rest in the waking state before relearning.

Ten male subjects were used in the experiments. All subjects went through all of the conditions of the experiment, but in different orders, so as to distribute the effects of practice throughout them. Unpracticed subjects were given three days of preliminary practice in nonsense syllable learning technique. The various syllable lists were circulated throughout the conditions of the experiment, insofar as possible, so that difficulty of list might not influence the comparative average scores. Only volunteer subjects were used, none of whom were reimbursed for their work.

The method of inducing the hypnotic state was primarily that outlined by McDougall (9). Various authors have advanced different criteria of the presence of the hypnotic state. Hull (7) gives an excellent discussion and criticism of these criteria. He concludes that probably the only psychological criterion of hypnosis is a heightened susceptibility to suggestion. Certain phenomena, however, usually appear in a deep trance state. Some of these are waxy plasticity, post-hypnotic amnesia, analgesia, negative and positive hallucinations. All or some of these phenomena may be present. However, a trained observer can usually detect the presence of the somnambulistic state by the total picture of the behavior of the hypnotized subject.

Only those subjects showing the deeper phenomena of the hypnotic state were used in the experiments here reported. The many subjects who appeared incapable of the phenomena of deep hypnosis were discarded. After the experimental work began no suggestions of post-hypnotic amnesia were made to the subjects for fear that the suggestion might lead them to simulate amnesia when there was no true amnesia present. This procedure is in contrast to that of Mitchell (16) who always gave suggestions of post-hypnotic amnesia to her subjects during the hypnotic trance.

The conditions of the experiments were as follows:

	Condition of Learning		Condition of Relearning
	Original Material	Interpolated Material	Original Material
	Experiment 1		
Condition A.	Waking	Waking	Waking
Condition B.	Waking	Trance	Waking
Condition C.	Waking	Trance Rest	Waking
Condition D.	Waking	Waking Rest	Waking
	Experiment 2		
Condition A.	Trance	Trance	Trance
Condition B.	Trance	Waking	Trance
Condition C.	Trance	Waking Rest	Trance
Condition D.	Trance	Trance Rest	Trance

Results.—Table VIII shows the average savings and anticipation scores of the conditions of Experiment I and the differences between the means of the experimental and their control conditions.

TABLE VIII

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Condition A.....	.3795±.0296		.1726±.0227	
Condition B.....	.4965±.0228		.2545±.0294	
Diff.....	.1170±.0293	3.99	.0819±.0286	2.86
Condition C.....	.6265±.0381		.5545±.0421	
Condition D.....	.4877±.0317		.4273±.0318	
Diff.....	.1388±.0396	3.51	.1272±.0420	3.03

An examination of the table shows a higher average anticipation and savings score for the dissociated conditions. While some of the critical ratios fall below the generally accepted standard of reliability, all of the differences are in a uniform direction. It should be noted how closely the average savings score of the dissociated Condition B approaches that of the single list Condition D. However, the average anticipation scores of the two last conditions mentioned are apparently reliably different.

Table IX shows the average savings and anticipation scores

TABLE IX

	Average Savings Score	D./P.E.D.	Average Anticipation Score	D./P.E.D.
Condition A.....	.4837±.0308		.2272±.0303	
Condition B.....	.6375±.0265		.3182±.0380	
Diff.....	.1538±.0359	4.28	.0910±.0403	2.26
Condition C.....	.7827±.0174		.5908±.0448	
Condition D.....	.6429±.0294		.4908±.0288	
Diff.....	.1398±.0318	4.38	.1000±.0437	2.29

of the conditions of Experiment II and the differences between the means of the experimental and their control conditions.

The directions of the differences between the means of the comparable conditions of Experiment II are uniform. The dissociated conditions again show an advantage over the

control conditions in average savings and anticipation scores. While the savings score differences appear to be true differences, the anticipation scores are not as reliable with regard to their differences.

It is to be noted that a higher average retention is to be found in the conditions of Experiment II. It thus appears that retention is better when recall and relearning occur in the hypnotic state than when they both occur in the waking state. This finding is in accord with that of the majority of the findings on the subject, as typified by the results of the experiments of Young (28), Dallenbach and Jenkins (4), etc.

The differences between the findings of this experiment and those of Mitchell (16) may possibly be traced to the differences in technique employed. Mitchell worked with but two subjects and, hence, considered her work largely exploratory in nature and her findings as tentative. She gave suggestions of post-hypnotic amnesia in those conditions in which hypnosis was employed. What effects such suggestions would have upon the average retention is not known. It is apparent from our study that post-hypnotic amnesia may result in some cases without suggestions to that effect. As far as can be determined from the description of her method, retention tests followed immediately after the interpolated activity. Further, she allowed a two-minute interval for the induction of the hypnotic trance whereas a ten-minute interval was allowed in these experiments.

The work in the field of hypnotic phenomena is still at an exploratory level. Authors are still in disagreement as to what constitutes hypnosis. Some regard somnambulance, only, as hypnosis, while others broaden the content of the term to include even the lightest phenomena.

It appears from the results here reported that when a second activity is dissociated from a first activity, by means of hypnosis, the resulting retention is higher than when no such a dissociation occurs. The dissociation of the two activities appears to be more or less complete, as evidenced by the proximity of the average savings scores of the dis-

sociated conditions to those of the comparable single list conditions.

Summary.—1. When the interpolated activity occurs in the hypnotic state and the original activity in the waking state, the resulting anticipation and savings scores are higher than when both activities occur in the waking state. The converse is also true.

2. Materials learned in the dissociated conditions show average savings scores closely approaching in size those of the comparable single list conditions.

3. When material is learned in the hypnotic state a greater retention is apparent than when material is learned in the waking state.

GENERAL SUMMARY AND CONCLUSIONS

The experiments of the present study were undertaken in an attempt to determine to what extent the amount of retroactive inhibition, following interpolated activity, would be reduced by lessening the possibility of associative connection between the original and the interpolated activities.

Four types of dissociation were studied: those involving (a) sensory mode of presentation of the material; (b) room environment; (c) hypnotic and waking states; (d) different motor activities.

The dissociation of the sensory modes of presentation of the materials had a significant effect upon the amounts retained. When the sensory mode of presenting the second materials was changed from that of the first, not only did higher average anticipation and savings scores result, but the average savings scores closely approached those of the conditions in which no interpolated material was introduced.

The dissociation of the two room environments in which the first and the second learning activities occurred led to approximately the same amount of retroactive inhibition as occurred in that condition where the two activities occurred in the same room environment.

When the first of two learning activities involved the motor pathways of one hand and the second the motor path-

ways of the other hand, there appeared to be less resultant retroactive inhibition than when both activities involved the same motor elements. The differences in retention scores, while not highly reliable, were uniform in direction and, at least, were indicative of a tendency.

The dissociation of the original and the interpolated activities, through the hypnotic technique, led to less retroactive inhibition than occurred where the two activities proceeded in the same state. The dissociation of the two activities gave average retention scores which closely approached those of the comparable condition in which but a single list was learned.

The experimental results here reported, except those on the dissociation of room environments, may be interpreted to lend further support to the Theory of Associative Interference as one of the explanations of retroactive inhibition.

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